

Index

A

Abrasion, 27, 336, 337, 348, 349
Aerodynamic force, 33, 61, 62, 75–78,
159–163, 165, 167, 171–173, 230,
232, 234
Aerodynamics, 33, 54, 120, 155–181, 194,
281, 357
Alpine ski, 53–102
Amonton, 18
Angle of attack, 41, 42, 157, 158, 161, 163,
171, 181, 196
Athletes, 24, 55, 110, 160, 187, 282,
318, 355

B

Ballistic, 56, 155, 167, 171, 361
Bias, 113, 356, 362, 371
Binding, 53, 58, 60, 61, 73–75, 78, 83–89,
94, 98–101, 113, 117, 160, 174, 360
Biology, 358, 365–370
Biomechanical, 62, 69, 110, 113, 118, 201,
247, 248, 305, 310, 366, 371
Biomechanics, 62, 110, 116, 357, 358, 363,
365, 369
Blades, 26, 29, 33, 34, 40, 45, 48, 111, 139,
235, 282, 283, 285–288, 298, 299,
302–310, 316, 318, 320, 323–327,
356, 357, 359–361, 363, 371
Bobsleigh, 38–40, 42, 43, 45, 47, 50, 69,
185–276, 281, 357, 360, 361, 364,
365, 369
Bobsleigh/bobsled, 43, 185–188, 198, 200,
201, 203, 207, 213, 216–225,
227–229, 232, 233, 236, 237,

239–241, 246–252, 257, 259–266,
268–276, 360
Body mass, 70, 111, 112, 116, 121–123, 166,
173, 176, 251, 291, 292, 326
Body position, 77, 83, 84, 95, 96, 285, 292,
293, 367
Boot, 54, 58–61, 70, 73–75, 77, 79, 94, 98,
100, 113, 174, 283, 316, 318, 319,
322, 356, 357, 359, 360, 368, 371,
376
Boundary conditions, 46, 78, 88, 180,
260, 307
Broom, 336–337

C

Cameras, 63–66, 68, 70, 97, 98, 100, 273, 287,
342, 351
Capillary force, 13
Capture volume, 61, 63, 64, 66–68
Carving, 20, 25, 26, 53, 60, 75, 78–79, 87, 89,
373
Centre of mass, 55, 63, 65, 66, 84, 85, 87, 92,
98–100
CFD. *See* Computational fluid dynamics
(CFD)
Clap skate, 283, 285, 287–288
Climb, 119, 366
Coaches, 54, 80, 123, 159, 160, 201, 274, 355,
358, 359, 364, 365, 369, 371–374,
376
Coefficient of friction, 18, 20, 23, 25, 29, 30,
34, 35, 42, 46, 299, 309, 323
Comfort, 58, 59, 315–319, 323

Competition, 53, 54, 56, 57, 61, 95, 109,
115, 119, 166, 171, 172, 175,
176, 186–188, 190, 194, 196, 198,
201–203, 207, 212, 214, 251, 256,
257, 260, 275, 281–284, 287, 292,
297, 309, 334, 336, 355–359, 361,
362, 364

Composite, 58, 69, 88, 125, 128, 146, 316,
323, 327

Computational fluid dynamics (CFD), 161,
162, 247, 249, 250, 359, 360

Contact, 2, 18, 33, 61, 115, 189, 283, 316, 344,
359

Crystals, 2–4, 9, 10, 18–21, 138, 139

Curling, 1, 7, 333–352, 358

Curl ratio, 341–343, 350

D

Dendritic snow crystal, 9

Drag, 12, 13, 24, 25, 29, 42, 57, 58, 72, 74–78,
80, 92, 95, 96, 120–122, 136–138,
155, 157, 158, 161, 163–166, 169,
171–173, 181, 203, 205, 206, 214,
215, 220, 230, 232, 234, 243–251,
253, 262, 272, 285, 290, 292–297,
302, 337, 348, 349, 359, 360

Drag force, 12, 42, 75, 77, 95, 96, 120, 136,
138, 155, 164, 171, 173, 243, 290,
292, 302, 349

Dry friction, 18–19, 22, 23, 301, 302

Dynamic friction, 109, 132–133

E

Edging, 72, 83, 84, 86–89, 98–100

Energy, 9, 18, 21, 33, 38, 46, 47, 56, 65, 80–82,
97, 109, 118, 121–123, 125, 138,
189, 206, 207, 212, 226, 257, 261,
276, 291, 292, 299, 300, 308, 316,
323, 325–327, 361, 366, 376

Enthalpy, 21

Environment, 6, 24, 42, 113, 128, 131, 200,
202, 256, 268–270, 272, 274, 288,
293, 295, 320, 355–358, 360, 361,
363–366, 372–376

Equipment, 24, 42, 54–61, 69, 72–77, 83, 84,
90, 99, 110, 112, 120, 123, 128, 131,
155, 158, 159, 162, 174, 189, 190,
201, 207, 257, 269, 282, 283, 297,
315, 318, 322–324, 334, 355–361,
363, 366–368, 370–376

Ergonomics, 54, 55, 58, 59, 113, 195, 206,
207, 360

Ethics, 355

Expanded polystyrene (EPS), 56

Experiments, 23–30, 35, 43, 48, 50, 54, 57, 89,
109–113, 115–119, 141, 146, 149,
157, 159, 167, 172, 214–216, 225,
247, 248, 299, 300, 310, 318–320,
337, 349, 352, 357, 362

F

Fabric(s), 57, 58, 293–297, 337

FAST, 45

FAST 2.0i model, 45, 48, 302–310

Flight, 98, 156–163, 169–180, 361, 370

Free stream turbulence, 295

Freezing procedure, 335

Friction, 2, 17–30, 33–50, 72, 109, 166, 190,
285, 315, 336, 363

Frictional heating, 8, 19–21, 23, 26, 30, 33, 35,
36, 298, 348

Friction coefficient, 5–8, 11–13, 20, 21, 25,
26, 29, 30, 33–38, 40–50, 92, 96,
101, 109–111, 115–117, 120, 121,
133–145, 203, 205, 206, 214–216,
225, 235, 239, 243, 250, 262, 292,
299, 301, 302, 306, 309, 310, 336,
338–349

Frontal area, 72, 75–78, 120–122, 204, 206,
245, 251, 285

G

Garment, 56, 367, 376

Gliding, 4, 17, 23–26, 80, 111–113, 115, 116,
131–138, 140–146, 155, 283, 285,
287

Global positioning system (GPS), 62, 63,
67–72, 74, 78, 82, 104, 232, 371

Grain size, 5, 12, 29

Grip, 17, 61, 109, 110, 115–118, 124, 125,
316, 324, 356, 360

Ground force, 54, 71–75

H

Handling, 325, 328, 360, 362, 368

Hardness, 23, 29, 45, 46, 83, 87, 88, 148, 149,
197, 214, 301, 305, 306, 323

Heart rate, 114, 369

Heat, 6, 8, 18–23, 33, 45–48, 59, 128, 139,
192, 202, 207, 299, 303, 308, 310,
335, 348, 365

Helmet, 54–56, 68, 70, 77, 99, 245, 246, 249,
283, 356, 357, 359, 360, 369

Hexagonal ice, 2–3

I

Ice, 1–13, 18, 33–50, 131, 186, 281–310, 315, 333, 356
 Ice hardness, 45, 46, 214, 305
 Ice hockey, 139, 315–328, 346, 371
 Ice sheet, 333–337, 342, 345–347, 349
 Ice-skate contact, 40, 216, 218, 222, 223
 Ice slippery, 298, 299
 Ice speed skating, 281, 282, 292, 298
 Ice structure, 21
 Inertial measurement unit (IMU), 41, 63, 67–72, 74, 78, 82, 371

K

Kinetic friction, 18, 33–38, 40, 42–44, 46, 48, 120, 251, 298

L

Lift force, 75, 76, 164, 166, 167, 171, 174
 Liquid, 9, 18, 20, 23–25, 45, 46, 189, 298–300, 306–308, 363
 Liquid layer, 20, 33, 35, 45
 Locomotion, 17, 119–123, 372
 Lubricant, 6–8, 19

M

Material, 1, 2, 5–8, 11, 20, 23, 24, 26, 33, 34, 43, 44, 55–61, 78, 83, 88, 111, 125–131, 141, 144, 146–149, 159, 189, 192–194, 196–199, 251, 283, 297, 300, 301, 316, 318, 319, 323, 327, 328, 357, 360, 368, 369, 373
 Measurement, 5, 7, 11–13, 21, 23–30, 34–43, 55, 58, 60–75, 77, 78, 80, 81, 95, 99, 101, 111–115, 117, 118, 141, 149, 156, 161, 165, 167, 168, 171–175, 178, 188, 197, 201, 202, 207, 212, 214, 216–225, 232, 238, 239, 252, 256, 287–289, 291, 293, 295, 309, 337, 349–352, 356, 362, 366, 371
 Mechanisms of curl, 347–349
 Melting point, 1–3, 7, 8, 18, 21, 27, 46, 139, 298, 300, 308, 343
 Melting temperature, 2, 7, 19, 22, 35, 45, 134, 135, 138, 141, 144, 302
 Microstructure, 56, 144–146
 Mixed friction, 19–20, 302
 Models, 8, 20, 35, 54, 113, 156, 201, 281, 315, 339, 357
 Motion capture, 59, 60, 64, 69, 102, 371
 Multibody, 84, 98, 237

Multi body model, 54, 83, 84, 93, 96, 98–102, 228, 236–243, 257, 262, 263, 266
 Muscle actuation, 96
 Muscles, 60, 72, 73, 79, 96, 97, 110, 189, 268, 283, 288, 316, 317, 320, 359, 366–369, 371, 373

N

Nordic/cross-country ski, 23, 24, 53, 109–149, 355, 364, 365, 372

O

Optimization, 25, 40, 54, 62, 83, 84, 90–93, 102, 121–131, 158, 161, 173, 195, 207, 227–251, 255–256, 259, 262, 263, 289, 360
 Optimum, 36, 38, 39, 131, 257–260, 274, 298, 309, 360
 Oxygen uptake, 110, 114, 118, 122, 291

P

Pebble, 335–340, 342, 344–346, 348–350, 352
 Penetration depth, 22, 47, 87–89, 94, 96
 Performance, 33, 54, 110, 155, 186, 283, 315–328, 355
 Physics, 33, 274, 358–362, 366
 Ploughing, 20, 25, 33, 36, 38, 39, 42, 44–47, 298, 306
 Polycrystalline ice, 4
 Polyurethane, 58, 60, 297
 Posture, 56, 72, 76–78, 80, 84, 98, 102, 120, 155, 156, 161, 165, 245, 247, 248, 250, 324, 356, 372, 374
 Power balance model, 291–292
 Pressure melting, 8, 18, 33, 35, 36, 45, 298–300, 308
 Push start time, 202, 203, 212

Q

Quasi-liquid layer, 20

R

Reynolds number, 19, 180, 244, 294, 295, 307, 359
 Roller ski, 109–119
 Rolling resistance coefficient, 110
 Rolling resistance measurements (RRMS), 112–114
 Roughness, 23, 36, 48, 57, 75, 76, 144, 145, 294, 302

Runner, 33–50, 185, 189–194, 196–199, 203, 206, 207, 209, 216, 218–220, 225, 238, 241, 243, 245, 246, 256, 263, 273, 274, 316

S

Safety, 25, 54, 55, 59, 60, 95, 187, 188, 191, 194, 200, 251, 255–256, 273, 283, 284, 319, 357, 359, 375

Simulator, 163, 236, 257, 268–276, 357

Skate, 1, 6, 7, 33–36, 40, 45, 48, 214, 216, 218–220, 222, 223, 225, 228, 232, 233, 235, 237–240, 281–283, 285–290, 298, 299, 302–310, 315–328, 366

Skating, 26, 34, 35, 48–50, 119, 123–131, 250, 281–310, 315, 316, 318–324, 346, 358, 363–365, 373

Skeleton, 36, 185–276, 357, 360, 363–365

Ski, 1, 17–30, 53–102, 109–149, 155–181, 185, 298, 356

Ski jump, 162, 163, 357, 361

Slalom, 54, 57, 63, 65, 66, 68, 70–72, 77, 78, 80–86, 90–93, 374

Sled, 33–35, 41, 42, 46–48, 185–190, 197–203, 206–215, 220, 221, 225–261, 263–265, 271–276, 357

Sliding, 4–8, 11–13, 23, 24, 33, 34, 42–45, 95, 96, 132, 133, 139–141, 203, 207, 225, 227, 231, 239, 255, 256, 298–310, 340–342, 345, 346, 348–352, 359, 360, 362, 368

Sliding speed, 33–38, 41, 42, 44, 46, 48–50, 214, 239, 361

Slipperiness, 1, 2, 5, 7, 8, 298

Snow, 1–13, 17–30, 53, 59–61, 63, 69, 71, 72, 77, 78, 80, 82, 83, 85, 87–92, 94, 96, 100, 101, 109–111, 113, 116–119, 122, 124, 125, 131–134, 137–139, 141, 144–146, 148, 149, 185, 333, 356, 358, 359, 361, 363, 364, 368, 369, 372, 376

Snow friction, 18–20, 23–25, 29, 72, 80

Solute, 10

Solvent, 10

Spectroscopy, 21

Speed, 7, 18, 33, 57, 109, 158, 186, 281, 315, 344, 359

Sport engineering, 82

Squeezing, 20, 23

Static friction, 110, 115–118

Statistics, 363, 375

Steer, 41, 212, 216, 220, 221, 238, 239, 257–259, 263–267

Stick, 132, 174, 315–328

Stone, 7, 333–352

Suit(s), 54, 56–58, 70, 76, 77, 89, 109, 155, 158, 159, 173–175, 177–179, 282, 287, 294, 295, 297, 320, 356, 357, 359, 373

Surface energy, 9, 299

Sweeping, 333, 337, 343–344, 349

T

Take-off, 95, 155, 159, 162, 163, 166–170, 173

Technology, 24, 27, 55, 58, 123, 172, 209, 256, 283, 297, 318, 355, 357, 366, 373–376

Temperature, 1–3, 5, 7–9, 11–13, 18–25, 27, 29, 30, 33–40, 42, 44–49, 59, 63, 73, 83, 109, 112, 133–135, 137–141, 144–146, 148, 149, 194, 197–198, 202, 207, 214, 260, 295, 298–302, 305, 308–310, 323, 327, 335–337, 343, 344, 349, 350, 352, 356, 360, 361, 363, 367, 369

Textiles, 56–58, 283, 294

Texture, 19, 23, 24, 57, 297

Total resisting force, 111

Track, 24, 34, 54, 109, 168, 186, 281, 320, 356

Training, 42, 61, 70, 83, 90, 95, 98, 109, 110, 115, 118, 159, 190, 208, 209, 214, 227, 256, 257, 268, 269, 272–274, 276, 315, 323, 361, 365, 366, 370, 373

Trajectory, 54, 61, 65, 66, 68–70, 80, 82–84, 87, 90–93, 98–102, 158, 200, 212, 213, 226, 228, 229, 231–233, 236, 255–257, 261–268, 319, 325, 341, 343–347, 361, 372

Treadmill, 109–114, 117, 119, 271, 275, 276, 371

Tribometer, 24, 26–30, 33, 37, 41

V

Viscoelastic behaviour/deformation, 11, 12

Vortex, 162, 195, 248, 297

V-shaped relation, 6, 8, 12

V-style, 159–161, 174, 180

W

Warm-up time, 112

- Water, 3, 6–9, 12, 13, 18–26, 29, 33, 34, 46,
59, 139, 144, 145, 180, 298, 303,
308, 335, 336, 341, 348, 349, 363,
367
- Water film, 6–8, 12, 13, 18–21, 23, 24, 26, 44,
138, 139, 145
- Water-snow mixture, 21
- Wax, 17, 18, 24, 111, 115, 116, 125, 356, 357,
363, 366
- Wet friction, 19, 20, 22, 30, 138
- Wind tunnel, 25, 33, 54, 58, 62, 76–78, 120,
156–159, 165–169, 171, 172, 174,
175, 178–180, 246–249, 292–296,
357, 359